

**National Environmental Policy Act (NEPA)
ENVIRONMENTAL EVALUATION NOTIFICATION FORM**

Grantee/Contractor Laboratory: BROOKHAVEN NATIONAL LABORATORY

Project/Activity Title: RHIC II

CH NEPA Tracking No.: BNL-455 Type of Funding: DOE Construction

B&R Code: _____ Total Estimated Cost: \$150,000,000

DOE Cognizant Secretarial Officer (CSO): R. Orbach, SC-1

Contractor Project Manager: Derek Lowenstein Signature: *Derek Lowenstein*

Date: 6/18/02

Contractor NEPA Reviewer: *Mark Davis* Signature: *Mark Davis*

Mark Davis

Date: 6/19/02

I. Description of Proposed Action:

The Relativistic Heavy Ion Collider (RHIC) was completed and commissioned in 1999. Successful operations and experiments were conducted in 2000, 2001 and 2002. RHIC's 2.4 mile ring has six intersection points where its two rings of accelerating magnets cross, allowing the particle beams to collide. The collisions produce the fleeting signals that, when captured by one of RHIC's experimental detectors, provide physicists with information about the most fundamental workings of nature. If RHIC's ring is thought of as a clock face, then the four current experiments are at 6 o'clock (STAR), 8 o'clock (PHENIX), 10 o'clock (PHOBOS) and 2 o'clock (BRAHMS). There are two additional intersection points at 12 and 4 o'clock where future experiments or accelerator upgrades were planned. This Proposed Action addresses one of those planned upgrades, RHIC II, plus the related supporting upgrades at other locations in the collider-accelerator complex.

RHIC II is a RHIC luminosity-upgrade project. It would consist of the following additions to the extant collider RHIC: a Linac-based heavy-ion injector (Electron Beam Ion Source (EBIS), Radiofrequency Quadrupole (RFQ) and an Interdigital H (IH) Linac), a dual 50-MeV Linac with storage rings at 4 o'clock at RHIC (eCooler), and an upgrade to the STAR and PHENIX detectors to handle the increased interaction rates at the intersection regions (IRs). It is planned that RHIC II would increase luminosity at the IRs by a factor of 40.

It is noted that the luminosity increases would not result from increases in intensity of the beam in the rings or the increases in the maximum number or particles per fill beyond the levels in the approved RHIC Safety Assessment Document. Thus, environmental impacts such as radioactive waste generation, total radioactivity in soil or water or air, and collective dose equivalent

would be the same as in the approved RHIC Environmental Assessment (DOE/EA #0508, December 1991).

Linac-Based Preinjector (EBIS, RFQ, and IH Linac)

The new preinjector would be housed in a new building, with a short tunnel section connecting to the existing Tandem-to-Booster (TTB) transfer line. The building would be large enough to allow for future expansion, such as sources for polarized ^3He or polarized deuterium injection, as well as space for EBIS improvements. The building would be located as close as possible to the Booster, but away from radiation areas so that one would have access during high intensity proton running, which may be occurring at the nearby 200 MeV Linac and Booster. The only shielding required would be some modest lead shielding close fit to the IH Linac structure to protect against x-rays.

The conventional facilities for the preinjector would provide approximately 550-square meters of new experimental space, a 150-square meter technical space, and a beam transport tunnel. The experimental space would house the EBIS, RFQ, IH Linac, cooling systems, power supplies, and controls. A 2-ton overhead crane would span the experimental area. The beam would be transported to the TTB line through a 3-meter diameter corrugated metal tunnel approximately 15-meter long exiting the north-west wall at the end of which a 5-meter long 0.3-meter diameter steel pipe connects to the TTB tunnel structure. The tunnel would provide space for quadrupole magnets and be shielded with earth cover as required. The technical space would include room for tech shops and a clean area for assembly and maintenance of source components.

The experimental building would be a 17-meter by 33-meter non-combustible pre-engineered steel frame on concrete footings and foundations and a standing seam metal roof. Exterior walls would be reinforced concrete construction below grade and insulated metal panel wall construction above. Walls and roof would meet or surpass energy conservation standards with sash of insulated double-glazing in thermal break aluminum framework. Parking would be provided for 5 workers.

The Linac-based preinjector would require a water-cooling system, including cooling tower. Cooling-tower water would be treated either with ozone or with biocides and rust inhibitors. Effluent from the cooling tower would be routed to the existing outfalls at the 200 MeV Linac.

The IH Linac may be superconducting and require liquid helium. It would likely use liquid helium from a dewar.

Site work would include modifications to the existing TTB Tunnel, concrete walls to retain earth, and parking. Trenching, excavation, backfilling as well as relocation, extensions, and connections to existing power, water, sanitary and storm sewers, alarm and telephone and computer networks would all be included.

The eCooler

The proposed action would install two electron accelerator systems in the 4 O'clock region of the RHIC ring (one system per ring). Each electron accelerator would consist of a photocathode RF electron gun ("Photoinjector"), a laser system to drive the photocathode, a superconducting linac section, an electron-beam-transport consisting of an evacuated tube and various magnets and a beam-dump, and a large superconducting solenoid. The copper photoinjector would generate an electron beam of about 100 mA at up to an energy of 4-MeV. The superconducting linac energy would reach up to 50 MeV. Energy recovery of the linac would be used, so that the electrons would be dumped at the photoinjector energy. The copper photoinjector would require a large amount of RF power, about 1 MW, and a water-cooling system, including cooling tower, associated with this system. Cooling-tower water would be

treated either with ozone or with biocides and rust inhibitors. Effluent from the cooling tower would be routed to the existing outfalls at RHIC.

The superconducting linac and superconducting solenoid cooling system would be a closed-loop helium refrigerator. The liquid helium refrigeration of the eCooler will involve either a new refrigerator or would use liquid helium from the RHIC plant but add expanders to reduce the liquid helium temperature to 2° Kelvin.

The photocathode laser would be a class 4 laser, running mode-locked CW operation in a wavelength of about 1 micron with harmonic generation to 0.5 micron.

The proposed eCooler facility would be located in the existing developed footprint of the RHIC 4 O'clock Intersecting Region (IR). Two buildings, one per ring, would be constructed to house the linac and support systems such as electronic racks, controls, water treatment systems, etc. New construction would also include the cooling tower and liquid helium machinery. The size of each building is estimated at 40 meters by 12 meters. Services such as water, power, telephone, fire alarm, etc., would come from existing utility systems. Access controls, such as gates, etc. would be used to prevent unauthorized access.

Acceleration of electrons at the proposed energy levels would result in low levels of activation at beam stops and equipment. At these electron energy levels, the generation of tritium would be expected to be at levels below monitoring and regulatory measures. A sampling program would be established to confirm anticipated levels.

The Upgrades at PHENIX and STAR Detectors

The STAR and PHENIX collaborations would upgrade the electronics and detectors at the IRs to handle the increased data rates associated with increased luminosity. This would result in increased power use by the experiments, which is anticipated to be less than 1 MW; increased heat load with corresponding increased cooling requirements, modified detectors or new detectors with cryogenic components and new detector gases.

There are no new planned structures such as buildings or cooling towers. Increased cooling would be handled by existing cooling systems or the existing cooling systems would be upgraded to handle the greater heat load. New counting gases would be typical of gases in use at the Alternating Gradient Synchrotron (AGS) and the Tandem Van DeGraff. New counting gases are not anticipated to have any environmental aspects such as ozone depleting characteristics.

II. Description of Affected Environment:

Luminosity increases at the IRs would not significantly increase the ambient radiation dose rate or activation of components and soil. The existing shielding used for personnel protection is designed for 2.28×10^{11} interactions per instantaneous fault of full beam at top energy. The corresponding dose for this many interactions is a few 10s of mrem depending on which IR one is working at. This dose estimate assumes one is working near the weakest shielded portions of the IRs during the fault. These weakest locations are near the labyrinth openings and other penetrations.

The design average luminosity for Au, which has yet to be achieved, is $2 \times 10^{26} \text{ cm}^{-2} \text{ sec}^{-1}$. Assume optimistically that one can increase this to $8 \times 10^{27} \text{ cm}^{-2} \text{ sec}^{-1}$. The cross-section (Au, Au - Brant-Peters formula) is 7.3 barns. This gives 58400 interactions per second. Using a 40-hour workweek and 30 colliding-beam-weeks per year yields 2.4×10^{11} interactions per year, which as

indicated in the previous paragraph corresponds to a few 10s of mrem per year. That is, this dose could be received by a person who worked 30 weeks per year while standing next to the weakest shielded locations at the RHIC IRs after the luminosity upgrade.

With increased luminosity there would be essentially no net increase in particles from that described in the RHIC Safety Assessment Document (SAD), however, the locations where the particles interact would change. With increased luminosity at the IRs, a few more particles would undergo beam-beam interactions at the IRs instead of interacting at the beam dumps or at the collimators. Even with the increased number of interactions at the IRs, the levels of soil activation would remain extremely low (essentially non-detectable). The PHENIX, STAR and BRAHMS IRs do not have overlying soil shielding and they are located on concrete pads. Therefore, any activation of soil would be limited to the soil that lies below the concrete pads. The buildings act as impermeable caps, which protects the soil from rainwater infiltration. Rainwater that infiltrates activated soil shielding can leach radionuclides (tritium and sodium-22) from the soil, and carry them into the groundwater. The IR housing PHOBOS has overlying soil shielding. Therefore, an assessment would be performed to ensure nearby soil is capped, if necessary, in accordance with the Design Practice for Known Beam-Loss Locations in the SBMS Subject Area on Accelerator Safety. Any locations required to be capped would consist of previously disturbed areas.

With the presence of a beam dump in the eCooler, the potential for soil activation and the need for engineered controls would be assessed in accordance with the Accelerator Safety Subject Area.

The affected area associated with the eCooler would include the previously disturbed area (currently parking lot and access road) immediately adjacent to the 4 O'clock intersecting region. Proposed new construction would include two new buildings, a cooling tower and associated piping. Because the area of effect is within the one-half mile corridor of the Peconic River and proximity to wetlands, BNL would submit to the New York State Department of Environmental Conservation an application for permit under the Wild, Scenic and Recreational River Systems Act.

The affected area for the EBIS would include construction of a new building. The proposed building site would be a previously disturbed area of soil and roadway adjacent to an existing power supply house (Building 908) for the Tandem to Booster Line. The accelerator enclosure, several inches of close-in shielding, would be designed to attenuate all radiation.

The proposed actions at both STAR and PHENIX detectors (electronics and detector upgrades) would be performed within the existing facilities.

No impacts to environmentally areas would be anticipated as a result of the proposed actions.

III. Potential Environmental Effects: (Attach explanation for each "yes" response and "no" response if additional information is available and could be significant in the decision making process.)

A. Sensitive Resources: Will the proposed action result in changes and/or disturbances to any of the following resources?	<u>Yes/No</u>
1. Threatened/Endangered Species and/or Critical Habitats	<u>No</u>
2. Other Protected Species (e.g., Burros, Migratory Birds)	<u>No</u>
3. Wetlands	<u>Yes</u>
4. Archaeological/Historic Resources	<u>No</u>
5. Prime, Unique or Important Farmland	<u>No</u>
6. Non-Attainment Areas	<u>No</u>
7. Class I Air Quality Control Region	<u>No</u>
8. Special Sources of Groundwater (e.g., Sole Source Aquifer)	<u>Yes</u>
9. Navigable Air Space	<u>No</u>
10. Coastal Zones (e.g., National Forests, Parks, Trails)	<u>No</u>
11. Areas w/Special National Designation (e.g., National Forests, Parks, Trails)	<u>No</u>
12. Floodplain	<u>No</u>
 B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated substances or activities?	<u>Yes/No</u>
13. Clearing or Excavation (indicate if greater than 5 acres)	<u>Yes</u>
14. Dredge or Fill (under Clean Water Act section 404; indicate if greater than 10 acres)	<u>No</u>
15. Noise (in excess of regulations)	<u>No</u>
16. Asbestos Removal	<u>No</u>
17. PCBs	<u>No</u>
18. Import, Manufacture or Processing of Toxic Substances	<u>No</u>
19. Chemical Storage/Use	<u>Yes</u>
20. Pesticide Use	<u>No</u>
21. Hazardous, Toxic, or Criteria Pollutant Air Emissions	<u>No</u>
22. Liquid Effluent	<u>Yes</u>
23. Underground Injection	<u>No</u>
24. Hazardous Waste	<u>Yes</u>
25. Underground Storage Tanks	<u>No</u>
26. Radioactive (AEA) Mixed Waste	<u>No</u>
27. Radioactive Waste	<u>Yes</u>
28. Radiation Exposures	<u>Yes</u>
 C. Other Relevant Disclosures. Will the proposed action involve the following?	<u>Yes/No</u>
29. A threatened violation of ES&H regulations/permit requirements	<u>No</u>
30. Siting/Construction/Major Modification of Waste Recovery or TSD Facilities	<u>No</u>
31. Disturbance of Pre-existing Contamination	<u>No</u>
32. New or Modified Federal/State Permits	<u>Yes</u>
33. Public controversy (e.g., Environmental Justice Executive Order 12898 consideration and other related public issues)	<u>No</u>
34. Action/involvement of Another Federal Agency (e.g., license, funding, approval)	<u>No</u>
35. Action of a State Agency in a State with NEPA-type law. (Does the State Environmental Quality Review Act Apply?)	<u>No</u>
36. Public Utilities/Services	<u>No</u>
37. Depletion of a Non-Renewable Resource	<u>No</u>

IV. Section D Determination: Is the project/activity appropriate for a determination by the Group Manager under Subpart D of the DOE NEPA Regulations for compliance with NEPA?

Yes

Indicate the recommendation and specific class of action from Appendix A-D to Subpart D (10 CFR 1021):

CX

B3.10 Siting, construction, operation, and decommissioning of a particle accelerator, including electron beam accelerator with primary beam energy less than approximately 100 MeV, and associated beamlines, storage rings, colliders, and detectors for research and medical purposes, within or contiguous to an already developed area (where active utilities and currently used roads are readily accessible), or internal modification of any accelerator facility regardless of energy that does not increase primary beam energy or current.

DOE Recommendation:

BAO NEPA Coordinator: Gerald Granzen

Signature:

Date:

LGL-GL: Irene P. Atney

Signature:

Date:

Group Manager Subpart D CX Determination and Approval:

The preceding pages are a record of documentation required under DOE Final NEPA Regulation, 10 CFR Part 1021.400, to establish that an action may be categorically excluded from further NEPA review. I have determined that the proposed action meets the requirements for the Categorical Exclusion referenced above. Therefore, by my signature below, I have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

Acting BAO Area Manager: Frank Crescenzo

Signature:

Date:

V. Additional Information

- A3 While the proposed action would not have a direct affect on wetlands, the area of effect would be within one-half mile of New York State designated freshwater wetlands. Therefore, BNL would submit an application for permit under the Wild, Scenic and Recreational River Systems Act to the New York State Department of Environmental Conservation (NYSDEC).
- A8 Although BNL is situated over a Sole Source Aquifer, operation of these accelerator facilities should not affect the aquifer. This would include discharges to the BNL sanitary and storm water systems. The BNL Standards Based Management System Subject Area "Liquid Effluents" provides requirements related to discharges. Work planning, experimental review, and Tier I safety inspections are the three methods for ensuring that hazardous effluents would not make their way into the sanitary waste stream or storm water discharges.
- B13 Excavation would be required to install the new buildings and the new piping associated with cooling tower discharge waters. Excavation would be limited to the area immediately adjacent the buildings and the piping route. While the excavation area will be less than 5 acres, standard construction techniques, such as silt-fences and/or straw-bales, would be used to control runoff during excavation. Excavated areas associated with the piping would be backfilled and returned to grade.
- B19 Routine operation and maintenance actions associated with the accelerator facilities would involve the use of chemicals or compounds, generally in small quantities. BNL's Chemical Management System would track the quantity, location, owner, and storage of any chemical inventory.
- B22 Any discharges associated with the proposed action, including cooling tower effluent, would be managed according to the BNL Standards Based Management System Subject Area "Liquid Effluents".
- B24 Routine operation and maintenance actions associated with the accelerator facilities would result in a small amount of hazardous wastes being generated, primarily cleaning compounds. The total volume generated would not be expected to exceed a few cubic feet per year and would not constitute a significant increase to Collider-Accelerator Department total estimates. All hazardous wastes would be managed in accordance with established BNL procedures and subject areas. Work planning, experimental review, and Tier I safety inspections are the three methods for ensuring wastes are minimized and controlled.
- B27 Routine operation and maintenance actions associated with the eCooler accelerator facility would result in a small amount of radioactive waste being generated. The total volume generated would not be expected to exceed a few cubic feet per year and would not constitute a significant increase to Collider-Accelerator Department total estimates. All radioactive wastes would be managed in accordance with established BNL procedures and subject areas. Work planning, experimental review, and Tier I safety inspections are the three methods for ensuring wastes are minimized and controlled.
- B28 Routine operation and maintenance actions associated with the accelerator facilities would result in low-level radiation exposures to workers. Interlocks, access controls, training and procedure administration would be used to minimize exposures and employ ALARA principles.
- C32 Because the area of effect is within the one-half mile corridor of the Peconic River and proximity to wetlands, BNL would submit to the New York State Department of Environmental Conservation an application for permit under the Wild, Scenic and Recreational River Systems Act.

Depending on the disposition of each cooling tower's discharge, the existing New York State Pollutant Discharge Elimination System (SPDES) permit would be revised as necessary. The two proposed cooling systems would be closed-loop deionized water systems using ion exchange beds that would be removed for regeneration or disposal by a contractor off site. In the case of the eCooler, the electron beam would not strike the water directly, so water activation could only occur due to bremsstrahlung produced when electrons strike the accelerating structure or the beam pipe. At the proposed beam currents and energies for the IH Linac, no induced activity would be expected. Discharge of contaminants to the ground or to the sanitary system would be neither planned nor expected from these cooling systems. Each closed loop cooling system would be connected to the cooling tower via a heat exchanger. Cooling-tower waters would be treated either with ozone or with biocides and rust inhibitors, and would meet all SPDES effluent limits.